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Patterns of technological learning within the knowledge systems of industrial clusters in emerging economies: Evidence from China

Bin Guo*, Jing-Jing Guo

School of Management, Zhejiang University, Hangzhou 310058, China

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ABSTRACT

Through an interview-based exploratory study and a follow-up survey-based quantitative analysis, this paper investigates the technological learning pattern in terms of structure and mechanisms of interaction within the knowledge system of two industrial clusters in China. Unlike the recent studies that suggest that industrial cluster comprises disconnected leader-centered communities, we argue that the different leader-centered communities within the knowledge systems of industrial clusters are not disconnected from each other. Instead, those communities are inter-connected through the so-called 'knowledge spanning mechanisms'. Regarding the interaction dimension of technological learning pattern, this paper argues that in analyzing learning behavior in the knowledge networks of industrial clusters, it is necessary to synthesize the learning opportunity perspective and the absorptive capacity perspective to better understand and explain the similarities and dissimilarities in technological learning behavior among different cluster types, across cognitive subgroups, and between product innovation and process innovation. Our study reveals that in the context of emerging countries, the following four factors are decisive for technological learning opportunities inside the knowledge networks of industrial clusters: the underlying complexity of technology in clusters, the inter-connectedness between product and process, path dependency in knowledge searching, and the incremental nature of a cluster's technological development.

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1. Introduction

A cluster is a form of network that occurs within a geographic location, in which the proximity of firms and institutions ensures certain forms of commonality and increases the frequency and impact of interactions (Porter, 1998, p. 226). During the past two decades, industrial clusters and their evolution have drawn lots of attention from both academic and policy arenas. One important reason for this is the fact that the emergence and roles of industrial clusters as an important industrial organization in the economic system have significantly challenged and changed the traditional rules of industry competition (Porter, 1990; Giuliani, 2007). Under such circumstances, policy-makers do not focus solely on large enterprises in building national capabilities, and geographical clusters of firms are seen as drivers of national competitiveness and economic growth. Therefore, the question of how to promote the formation, development and upgrading of industrial clusters has been emphasized in policy-making for regional development around the world since the 1990s.

After the market reformation in 1979, industrial clusters developed very rapidly in both number and scale in China. Clusters have been a significant component of the provincial economies of coastal China (Kang, 2007), which is one of the most important contributors to the higher economic growth rate in the eastern coastal regions of China, as compared with that of their inland counterparts (Zhang et al., 2004). Zhejiang province, one of the most prosperous coastal regions in China and the host area of the sample clusters in the present study, is home to many industrial clusters ranging from labor-intensive (e.g., socks, neckties, and cigarette lighters) (Hessler, 2007) to capital-intensive products (e.g., metalworking products, electric parts, and automobile parts) (Marukawa, 2006). One interesting fact is that most firms are small, except for a few core firms in these industrial clusters. However, when these small firms agglomerate, they have achieved strong competitive strength and market presence. For instance, Wenzhou makes 70 percent of the world's cigarette lighters. Forty percent of the world's neckties are made in Shengzhou (Hessler, 2007). Datang, the so-called Socks City of China, produces an astounding nine billion pairs of socks each year (Barboza, 2004). As described in a report in Los Angeles Times, "China's advantages in the global marketplace are moving well beyond cheap equipment, material and labor. The country also exploits something called clustering....China has created giant industrial districts in distinctive entrepreneurial

* Corresponding author. Fax: +86 571 88206827.
 E-mail address: guob@zju.edu.cn (B. Guo).

enclaves such as Datang. Each was built to specialize in making just one thing...” (Lee, 2005).

Among studies on industrial clusters, one characteristic trend is that the knowledge-based perspective is widely used in analyzing learning and innovation behaviors therein. As suggested in Baptista and Swann (1998, p. 538), one of the main reasons behind the existence and success of clusters is the pervasiveness of knowledge externalities or spillovers. The knowledge and learning processes of the main actors are key elements to understanding the rise, growth and transformation of a cluster (Breschi and Malerba, 2001). Furthermore, the crucial role of knowledge and learning can be clearly demonstrated by the various definitions of an industrial cluster in the literature. Besides Porter (1998), a few other researchers have also expressed similar ideas. For instance, industrial clusters are defined in Giuliani and Bell (2005, p. 47) as “geographic agglomerations of economic activities that operate in the same or inter-connect sectors”; Morosini (2004, p. 307) stated that “an industrial cluster is a socioeconomic entity characterized by a social community of people and a population of economic agents localized in close proximity in a specific geographic region. Within an industrial cluster, a significant part of both the social community and the economic agents work together in economically linked activities, sharing and nurturing a common stock of product, technology and organizational knowledge in order to generate superior products and services in the marketplace”. Similarly, an industry cluster is defined by Rosenfeld (1997, p. 10) as “a geographically bounded concentration of similar, related or complementary businesses, with active channels for business transactions, communications and dialogue, that share specialized infrastructure, labor markets and services, and that are faced with common opportunities and threats”. Although these definitions have some slight differences, they share three common points. Firstly, all of them posit that geographic proximity and economical linkages among cluster firms are the basic characteristics of industrial clusters. Secondly, they stress that individual firms in clusters have certain forms of commonality such as access to specialized factors, a supply of intermediate products, infrastructures and cultural embeddedness. Among those forms of commonality, one of the most important elements is a common stock of knowledge (e.g., the knowledge embedded in the pooling of specialized workers) that is created and shared by firms inside a cluster. Thirdly, they all argue that firms in clusters have frequent interactions, which are mainly reflected in the acquisition of knowledge, as well as in sharing, diffusing and creating it. A host of linkages among cluster members results in a whole greater than the sum of its parts (Porter, 1998, p. 81). As a result, learning through networking and by interacting is seen as the crucial force pulling firms into clusters and the essential ingredient for the ongoing success of an innovative cluster (Breschi and Malerba, 2001).

Generally speaking, the knowledge perspective literature on industrial clusters can be categorized into two strands. One is the Marshallian perspective, and the other is the localized knowledge spillovers (LKS) perspective (Breschi and Malerba, 2001; Maskell, 2001b; Giuliani, 2007). As for the Marshallian perspective, the research focus in past literature was heavily on transaction-based production systems, instead of learning-based knowledge systems in industrial clusters. Besides, they usually hypothesized that ‘*knowledge in the air*’ is pervasively distributed and freely shared. Local firms are generally assumed to be more willing to share knowledge with others because common norms and values have prevented cheating and opportunistic behavior (Harrison, 1992). By contrast, the LKS Perspective asserted that knowledge systems and production systems obviously overlap, but that they are not identical (Bell and Albu, 1999, p. 1723). In order to solve the inherent ambiguity of the concept of localized knowledge spillovers, which to date is considered by many as a ‘black box’ (Breschi

and Lissoni, 2001), the literature also emphasized the need to place firm-level learning at the center of cluster analyses with the objective of understanding the nature and characteristics of a cluster’s innovative process (Bell and Albu, 1999; Maskell, 2001a; Martin and Sunley, 2003; Giuliani, 2005, 2007). In particular, some of the recent cluster studies have emphasized that knowledge is not diffused evenly ‘in the air’ (Power and Lundmark, 2004; Giuliani and Bell, 2005). Rather, innovation-related knowledge is diffused in clusters in a highly selective and uneven way (Lissoni, 2001; Morrison, 2004; Giuliani, 2005, 2007; Boschma and ter Wal, 2007).

Undoubtedly, these recent studies are helpful in opening up the above-mentioned ‘black box’. However, much effort is still required in this direction. First of all, two crucial drawbacks exist in the existing studies. On the one hand, when attention has turned to technological change in clusters in developing countries, these materials-centered structures and flows have usually remained at the center of the analysis (Bell and Albu, 1999). However, as indicated earlier, we need to distinguish knowledge systems from the associated ‘production systems’ that comprise materials-centered systems of production and trade. On the other hand, among studies on learning and innovation in clusters, most are about clusters in developed countries. In industrialized countries, clustering often occurs in high-tech (e.g., science parks) or design-intensive branches and involves substantial product and process innovations (Altenburg and Meyer-Stamer, 1999). It should be pointed out that the manufacturing clusters in developing countries have some different characteristics as compared to those in developed countries. For manufacturing clusters in developing countries, innovation strategies depend more on imitation than on innovation, and they are more market-led than technology-driven. Besides, most of the knowledge in clusters is not concerned with core technology and research activities but instead has to do with know-how and skills in the more down-stream phase of innovation. Therefore, the present study attempts to gain some insight into the knowledge system by empirically examining the roles and influencing mechanism of technological learning and knowledge spillover in manufacturing clusters.

Another more important problem is that some recent studies from the LKS perspective have adopted a single-mechanism analysis while ignoring the potential complementary and/or substitution relationship among different knowledge transmission mechanisms. We argue that it is necessary to bring local and non-local, formal and informal, knowledge transfer and knowledge spillover, and personal and impersonal knowledge acquisition channels into our research on knowledge network and technological learning in industrial clusters. Furthermore, most important of all is that the big picture of the structure of knowledge systems inside clusters in the past literature (e.g., Lissoni, 2001; Morrison, 2004; Giuliani, 2005; Boschma and ter Wal, 2007) is described as comprising a few disconnected leader-centered communities, in which the leading producers act as gatekeepers for their own network. We argue that different leader-centered communities within clusters are not disconnected. Instead, these communities are inter-connected through what are called ‘*knowledge spanning mechanisms*’. We attempt to provide some empirical evidence for the existence of such knowledge spanning mechanisms in the present study.

The goal of the present study is to investigate the technological learning pattern in terms of structure and mechanisms of interaction within the knowledge system of industrial cluster through an interview-based exploratory study and a follow-up survey-based quantitative analysis of two industrial clusters in Zhejiang province, China. Specifically, in this paper, we define a *producer-centered community* as a group of associated units (e.g., suppliers–producers–clients) along the supply chain that formed through production and trade relationships in the production network of an

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